UNIVERSITI PUTRA MALAYSIA

BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER SIMULATED OUTDOOR AND INDOOR BIOPARK

MAKE JIWAN

FP 2000 26

BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER SIMULATED OUTDOOR AND INDOOR BIOPARK

By

MAKE JIWAN

Thesis Submitted in Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Agriculture
Universiti Putra Malaysia

August 2000

To God, Mom, Dad, brothers and sisters, lovely daughter Ellwylnea Dorantez, beloved wife, and to all the animals and flowers that have enriched my life

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER SIMULATED OUTDOOR AND INDOOR BIOPARK

By

MAKE JIWAN

August 2000

Chairman: Professor Dr. Dahlan Ismail

Faculty: Agriculture

The biocompatibility between flora and fauna in BioPark was evaluated. A group of 20 heads of *Cervus timorensis* (Timorensis), 5 heads respectively of *Axis axis* (Axis), *Cervus unicolor brookei* (Sambar) and *Muntiacus atherodes* (Muntjac) were studied in Outdoor BioPark. In Indoor BioPark, 16 heads of *Callosciurus prevostii borneansis* (Prevost's squirrel), 10 heads of *Tragulus javanicus* (Kancil) and 6 heads of *Tragulus napo* (Pelandok) were used for the purpose of study. In Outdoor BioPark, the biocompatibility between the deer species with *Acacia mangium* and its natural vegetation were studied. Meanwhile in Indoor BioPark, introduced flora species were used.

The study found that the undergrowth vegetation of *A. mangium* plantation was biocompatible with the tested deer species. With monthly forage yield of

183.28 kg (DM) per ha or 1392.93 MJ ME per ha with 75% total available forage grazed, the *A. mangium* undergrowth could be stocked with 5 to 9 heads of Muntjac, or 1 to 3 heads of Timorensis, or 2 to 7 heads of Axis, or 1 to 2 heads of Sambar deer. Based on captive feeding habit and requirements of the Mousedeer species, the area also could be stocked with Kancil and Pelandok with allowable carrying capacity of 18 to 42 heads of Pelandok and 44 to 132 heads of Kancil, respectively.

It was found that some of the deer was not biocompatible with *A. mangium* stands. Of all the deer species tested, it was found that only Sambar and Muntjac were biocompatible and did not cause any significant debarking damage on the matured stands of *A. mangium*. Biocompatibility between deer species and *A. mangium* was influenced by tree bark architecture (bark surface coarseness) and taxonomy (thickness), deer species, number of individual stags stocked and the animal's feed management.

The biocompatibility between Prevost's squirrel, Pelandok and Kancil with introduced flora in Indoor BioPark had found that feed factor in terms of quantity and availability together with the availability of juvenile individuals were the most associated factors with the animal's herbivory. Other factors were includes the animal's stocking rate and plant's species used.

Understanding of the factors associated with the animals herbivory could help in the development and management of an ecologically balanced and healthier BioPark ecosystem. BioPark management measures in relation to flora-fauna biocompatibility were fully discussed through out the study. Healthier and ecologically balanced BioPark not only contributed to the fauna and flora well-being but also to the satisfaction of visitors and their better understanding towards conservation. This study concluded that the biocompatibility between flora and fauna was influenced by many manageable factors.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

BIOKESERASIAN ANTARA FLORA DAN FAUNA DI DALAM BIOPARK LUARAN DAN DALAMAN YANG DISIMULASIKAN

Oleh

MAKE JIWAN

Ogos 2000

Pengerusi: **Profesor Dr. Dahlan Ismail**

Fakulti: **Pertanian**

Biokeserasian antara flora dan fauna dalam BioPark telah dikaji. Kumpulan yang terdiri daripada 20 ekor *Cervus timorensis* (Timorensis), 5 ekor *Axis axis* (Axis), 5 ekor *Cervus unicolor brookei* (Sambar) dan 5 ekor *Muntiacus atherodes* (Kijang) telah dikaji di dalam BioPark Luaran. Dalam BioPark Dalaman, 16 ekor *Callosciurus prevostii borneansis* (Tupai Gading), 10 ekor *Tragulus javanicus* (Kancil) dan 6 ekor *Tragulus napo* (Pelandok) telah digunakan untuk tujuan kajian. Dalam Outdoor BioPark, biokeserasian antara spesies rusa dengan *Acacia mangium* dan tumbuhan semulajadinya telah dikaji. Dalam pada itu, dalam BioPark Dalaman, flora yang digunakan adalah kesemuanya terdiri daripada spesis yang diperkenalkan.

Kajian mendapati bahawa tumbuhan bawah yang terdapat di kawasan penanaman *A. mangium* adalah bersifat bioserasi dengan spesies rusa yang dikaji. Dengan pengeluaran foraj bulanan sebanyak 183.28 kg (berat kering) ataupun 1392.93 MJ ME per ha dengan 75% jumlah foraj digunakan, tumbuhan bawah *A. mangium* boleh menampung sebanyak 5 ke 9 ekor Kijang, atau 1 ke 3 ekor rusa Timorensis, atau 2 ke 7 ekor rusa Axis atau 1 ke 2 ekor rusa Sambar. Berdasarkan kajian sifat pemakanan dan keperluan dalam sangkar, kawasan ini juga dapat membekalkan makanan kepada Kancil dan Pelandok dengan jumlah penstokan antara 18 ke 42 ekor Pelandok dan 44 ke 132 ekor Kancil, masing-masingnya.

Didapati bahawa ada antara spesies rusa berkenaan tidak bioserasi dengan pokok *A. mangium.* Dari kesemua spesies rusa yang dikaji, didapati cuma Sambar dan Kijang yang bersifat bioserasi dan tidak menyebabkan kerosakan pembuangan kulit yang bererti terhadap pokok *A. mangium.* Biokeserasian antara rusa dengan *A. mangium* adalah dipengaruhi oleh sifat arkitek (kekasaran permukaan) dan taksonomi kulit pokok (ketebalan), spesies rusa, bilangan individu rusa jantan distok dan pengurusan permakanan haiwan berkenaan.

Biokeserasian antara *C. prevostii borneansis*, *T. napo* dan *T. javanicus* dengan flora yang diperkenalkan dalam Indoor BioPark, adalah didapati bahawa faktor pemakanan dari segi kuantiti dan kedapatan dan kedapatan individu juvenil

adalah faktor yang paling berkaitan dengan tingkahlaku pemakanan haiwan berkenaan. Faktor lain yang dikenalpasti termasuk kadar penstokan dan spesies tumbuhan yang digunakan.

Pemahaman faktor yang berkaitan dengan pemakanan haiwan dapat membantu dalam pembangunan dan pengurusan BioPark supaya berada dalam keadaan kestabilan ekologi dan persekitaran BioPark yang sihat. Langkah-langkah pengurusan BioPark dari segi biokeserasian flora dan fauna dibincangkan dengan terperinci dalam kajian ini. Keadaan ekosistem BioPark yang sihat dan stabil dari segi ekologinya bukan sahaja menyumbang kepada pembentukan dan kebajikan haiwan tetapi juga untuk kepuasan pengunjung dan permudahkan pemahaman mereka terhadap konservasi. Kajian ini menyimpulkan bahawa, biokeserasian antara flora dan fauna adalah dipengaruhi oleh faktor yang boleh-urus.

ACKNOWLEDGEMENTS

My heartiest appreciation to my Supervisory Committee Chairman Prof. Dr. Dahlan Ismail for his supervision, constructive criticisms, advices and friendship. I am extremely grateful for the many hours he spent on stimulating discussions, advice in seminar presentations as well as the preparation of this thesis.

My sincere thanks also forwarded to my Supervisory Committee Members Assc. Prof. Dr. Mustafa Kamal and Dr. Halimatun Yaakub for their valuable advice, attention and constructive criticisms in completing this study.

Thanks a lot to the staff of Multi Spp. Unit, Mr. Khairulnizam and Mr. Maridon for their assistance and the staff of the Department of Animal Science. Thanks also given to IRPA for funding of this study (Project No. 51233) and also PASCA for funding my study.

Thank you,

I certify that an Examination Committee met on 1st August 2000 to conduct the final examination of Make Anak Jiwan on his Master Science thesis entitled "Biocompatibility between Flora and Fauna under Simulated Outdoor and Indoor BioPark" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

MOHD. RIDZWAN ABD. HALIM, Ph.D.
Associate Professor/Head of Department
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

DAHLAN ISMAIL, Ph.D.
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

MUSTAFA KAMAL MOHD. SHARIFF, Ph.D.
Associate Professor/Dean
Faculty of Design and Architecture,
University Putra Malaysia
(Member)

HALIMATUN YAAKUB, Ph.D.
Faculty of Agriculture,
University Putra Malaysia
(Member)

MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor/Deputy Dean of Graduate School,
University Putra Malaysia

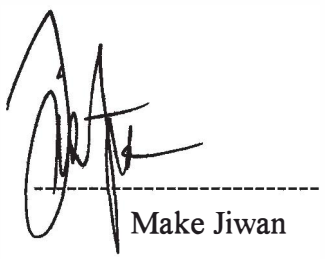
Date: 24 OCT 2000

This thesis submitted to the Senate of Universiti Putra Malaysia and was accepted as fulfilment of the requirement for the degree of Master Science.

KAMIS AWANG, Ph.D,
Associate Professor
Dean of Graduate School,
Universiti Putra Malaysia

Date: 11 JAN 2001

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



Make Jiwan

Date: 18/10/2000

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF ABBREVIATIONS

Most abbreviations used in this thesis are preceded on first mention by the full name. However, those more frequently repeated are listed below for easy reference.

DBH	diameter at breast height
GBH	girth at breast height
SGBH	stem debarked at GBH
CP	crude protein
EE	ether extracts
ADF	acid detergent fibre
NDF	neutral detergent fibre
GE	gross energy
ME	metabolisable energy
DMD	dry matter digestible
DSI	damage severity index
DA	debarked area
MDMY	monthly dry matter yield
DM	dry matter
MJ	Mega Joule
DMI	dry matter intake
PBR	percentage of plant biomass removed
PL	biomass lost
Ai	percentage availability
Ui_{bro}	percentage utilisation for browsing damage
Ui_{deb}	percentage utilisation for debarking damage
Pr_{browse}	preference ratio for browsing damage
Pr_{debark}	preference ratio for debarking damage
SAS	Statistical Analysis System
DMRT	Duncan Multiple Range Test
CRD	Completely Randomised Design
ANOVA	Analysis of variance
SD	Standard deviation

CHAPTER 1

INTRODUCTION

In these modern days of the industrialisation and urbanisation process, destruction of natural habitat through logging, agricultural, housing and industrialisation activities had caused conflict on land use. Utilisation of the available forest resources, idle mining and agricultural lands through plant-animal integration will reduce the conflict besides conserving and improving the natural habitat and landscape. Besides conflict on land use, we also face the conflict on the way we have exhibited and educated the public about the importance of flora and fauna. The possible factors that contributed to this phenomenon was most possibly on the way we had managed and utilised our natural resources such as wildlife and forest resources.

Previously we had exhibited the wildlife in zoological park and flora in botanical garden but the availability of these natural resources in their natural habitat, do not give better economic and educational importance to the country and the public except in national parks, forest parks, or wildlife sanctuaries. Therefore, in order to optimise the utilisation of the natural resources sustainable and to help the public to better understand the importance of both fauna and flora, the application of BioPark concept could fulfil these necessities. According to Gould (1991) the existence of BioPark was due to the recognition of the inseparable relationship between flora,

fauna and humans. The concept of BioPark is to generate the habitat of the appropriate animal by using suitable plants and consideration of other physical and physiological needs of the animals or plants. Dahlan (1998) noted that BioPark elements should exist in a non-barrier area of a balance ecosystem and foremost , Page (1990) noted that the BioPark was a place to tell the story of our evolutionary, ancestry, and the growth of human culture, arts, and artefacts.

The theory and principle of BioPark is to portray life in all their interconnectedness within one bio-exhibit in an ecologically balanced ecosystems. BioPark is not confined to wildlife conservation, recreational, entertainment and education but the concept also can be used in livestock production to give better return to the investor (Dahlan, 1998). The increasing demands for outdoor recreation activities, the availability of BioPark in the urban and suburban areas with beautiful landscape and facilities could fulfil the need. Thus, BioPark is a new idea in utilisation of natural resources of flora and fauna (domesticated or wildlife).

BioPark can be categorised into indoor and outdoor. Almost all the elements for outdoor and indoor BioPark are the same except that indoor BioPark is developed within a building compound. Meanwhile, outdoor BioPark develops in a limited area of a natural ecosystem. Each BioPark has their owns characteristics. Some BioPark developed as single species, and some as multi-species parks. For example, Kuala Lumpur Lake Garden is considered as one multi species BioPark as a whole but the

animals were displayed as mono-species which include Mousedeer Garden, Butterfly Garden and Deer Garden (Fallow deer). Meanwhile, the best example for multi species BioPark is Parliament Garden, which contained various species of deer (Sambar, Timorensis and Chital deer). The aim of BioPark is to promote good animal welfare, genetic diversity and educating the public about animal behaviour and habitat through the simulation of the natural habitat of animals as well as allowing the animals to display of more natural behaviour (Ford and Stroud, 1993).

In general, vegetation, soil, air, macro and micro fauna form our environment.. But of all these, vegetation plays a major role in stabilising the structural configuration of nature. Therefore flora is the most important component in BioPark. Vegetation aided the creation of habitat that sustain and enhances BioPark. Therefore, the selection of plant must suit the habitat as well as the animals and human requirements in the BioPark. The environment of the BioPark must look natural and closely resembles the animal natural habitat. Through the integration of indoor and outdoor BioPark, it will be a place for education, inspiration, amusement, entertainment and healing of some diseases (neuro-phsycotheraphy). This contextual approach not only allows for cognitive learning but also encourages effective learning about the animals and plants. Somehow, the success of the application of the BioPark concepts is depending on the understanding of the factors involved.

Without fauna the landscape of the BioPark will not become alive and attractive. Dahlan and Nik Marzuki (1996) noted that small herbivores and pheasants together with exotic and wildlife species were most preferred compared to carnivores, omnivores, reptiles and large mammals. Herbivores like Cervidae and Tragulidae and small mammals like shrews, squirrels and non-predator animals are also suitable. The choice of plants and animals for a BioPark should be based on characteristics of the site and indigenous species. Local or native species of flora and fauna should be the first priority. Fauna species introduced to the BioPark can be monospecies or multispecies combinations (Dahlan, 1998). The flora and fauna used should create a balance landscape that is sustainable. To create such a landscape, biocompatibility issues between flora and fauna need to be considered.

1.1 Justification

The close proximity between flora and fauna in a confined environment often resulted in damage to the flora. The damage is often severe between herbivorous animals and plants that are susceptible and palatable. However, toxic and unpalatable plants will be spared. Nevertheless, their presence might be a threat to these animals as accidental ingestion can lead to animal fatality (Knight and Dorman, 1997). Thus, the relationship between herbivorous animal and plants should be look from both aspects i.e. the impact of animals on plants in relation to their herbivory activities as well as the impact of plants on animals. This is essential because plant is not only